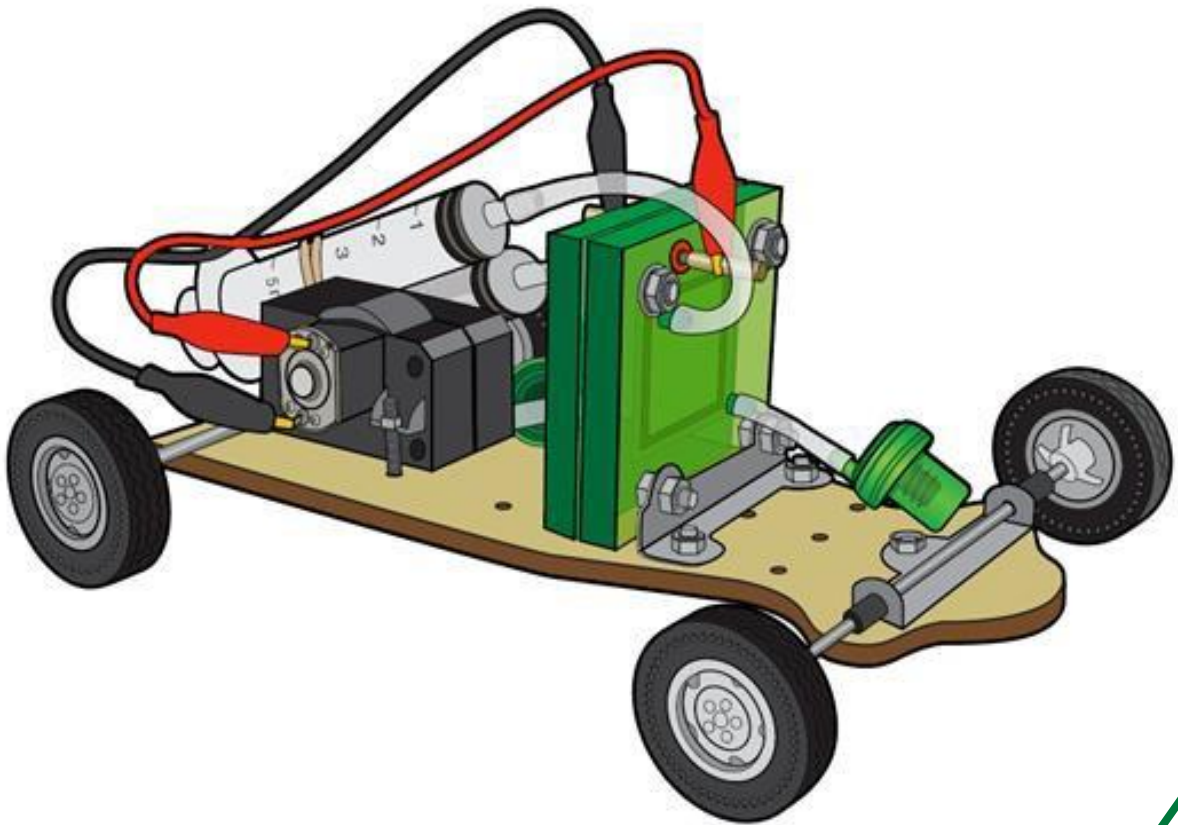


A World In Motion® **Fuel Cell Challenge** Competition Guide



PEM Fuel Cell Operating Procedures

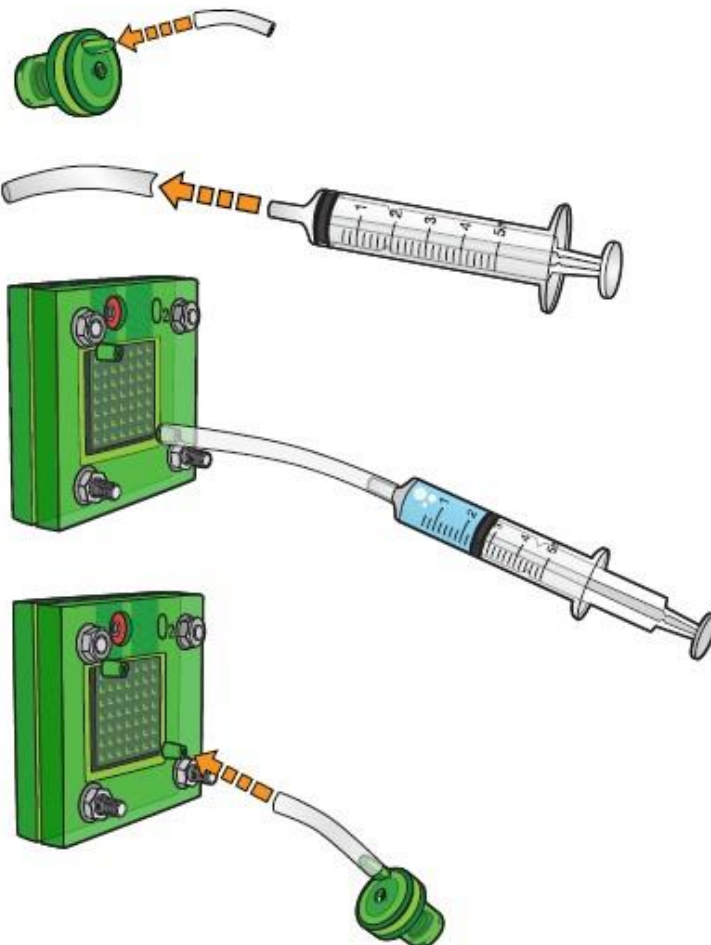
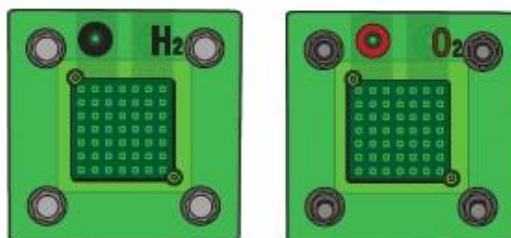
FUEL CELL OPERATION AS AN ELECTROLYZER

The fuel cell has two sides that can be identified by a decal near the top nozzle and are also color-coded: red (positive) is the Oxygen side and black (negative) is the Hydrogen side. When using the fuel cell in the electrolyser mode the polarity is extremely important because the fuel cell can be ruined if a current is applied to the fuel cell incorrectly; always attach the red (positive) clip from the battery pack to the Oxygen side and the black (negative) clip to the Hydrogen side.

Before using the fuel cell some flexible tubing will need to be attached to the pressure relief valves and the syringes so that they may be attached to the nozzles on the fuel cell. A one inch long piece should be attached to each pressure relief valve, and a two inch long piece attached to one of the syringes, and a three inch long piece attached to the other syringe.

Step 1

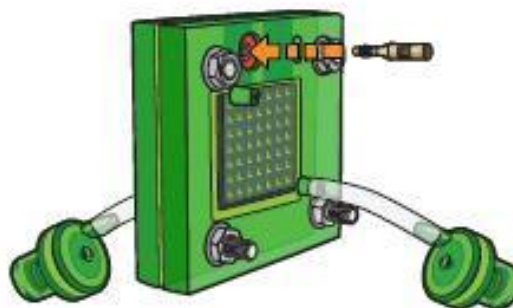
Hydrate the membrane of the fuel cell by adding distilled water to the Oxygen side of the fuel cell. Do this by drawing about 1 ml of distilled water into a syringe and injecting it into the bottom nozzle of the Oxygen side of the fuel cell (some water will leak from the top nozzle). **Never operate the fuel cell without insuring that there is water in the oxygen side of the fuel cell.** Remove the syringe from the bottom nozzle and attach a pressure relief valve to this nozzle. Also attach a pressure relief valve to the lower nozzle on the Hydrogen side of the fuel cell.



PEM Fuel Cell Operating Procedures

Step 2

Insert banana clips into both sides of the fuel cell (these will be the contacts for attaching leads to the fuel cell; remember – red is positive and black is negative; red is the oxygen side and black is the hydrogen side).



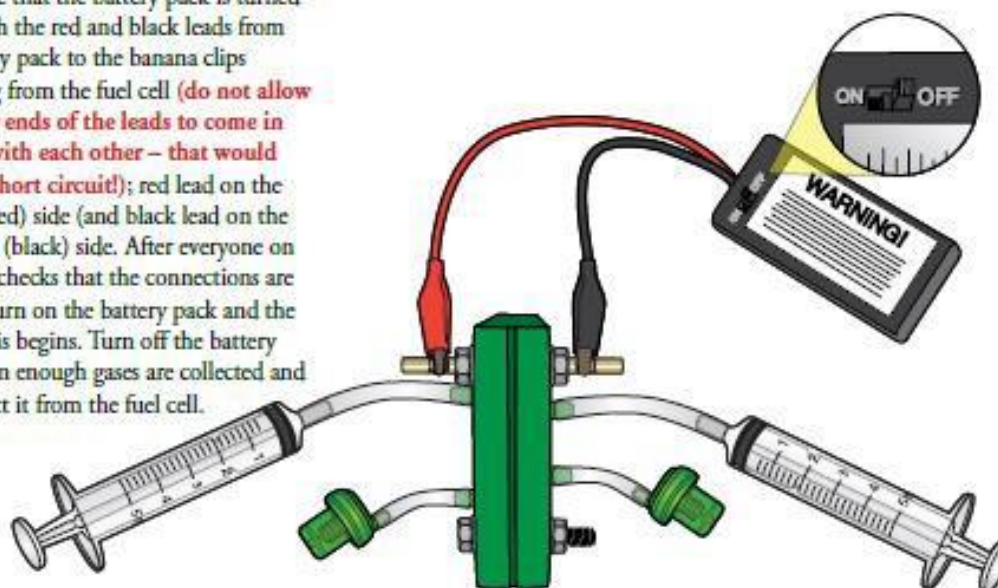
Step 3

Attach a syringe to the top nozzle on each side of the fuel cell (these will be for gas storage).



Step 4

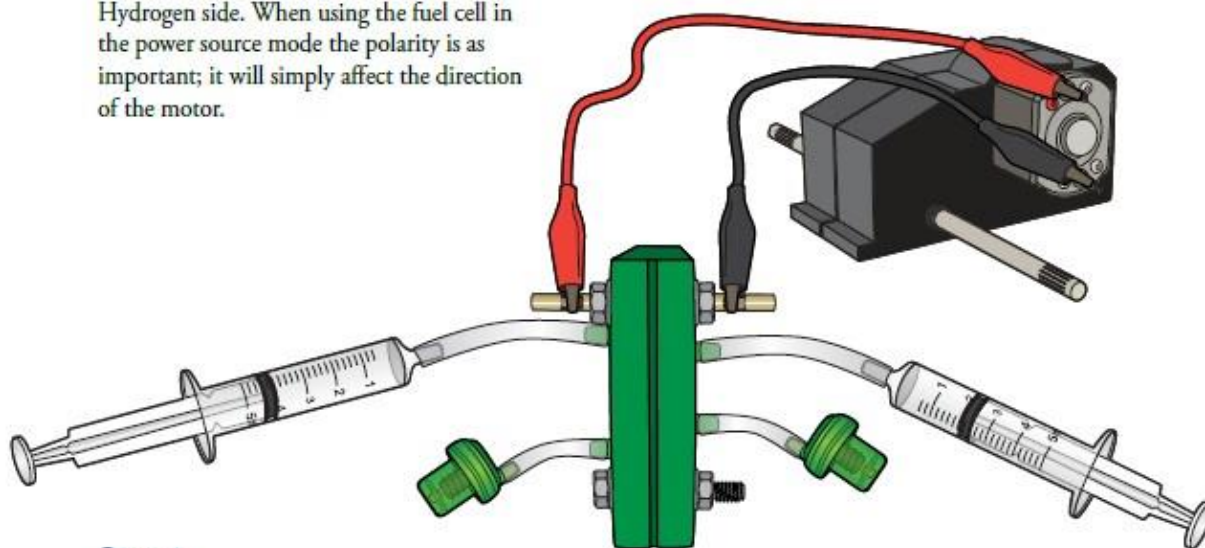
Make sure that the battery pack is turned off! Attach the red and black leads from the battery pack to the banana clips extending from the fuel cell (**do not allow the other ends of the leads to come in contact with each other – that would create a short circuit!**); red lead on the oxygen (red) side (and black lead on the hydrogen (black) side). After everyone on the team checks that the connections are correct, turn on the battery pack and the electrolysis begins. Turn off the battery pack when enough gases are collected and disconnect it from the fuel cell.



PEM Fuel Cell Operating Procedures

FUEL CELL OPERATION AS A POWER SOURCE

The fuel cell has two sides that can be identified by a decal near the top nozzle and are also color-coded: red (positive) is the Oxygen side and black (negative) is the Hydrogen side. When using the fuel cell in the power source mode the polarity is as important; it will simply affect the direction of the motor.



Step 1

Attach the red lead to the banana clip from the Oxygen (red) side of the fuel cell and attach the black lead to the banana clip from the Hydrogen (black) side; **do not allow the other ends of the leads to come in contact with each other – that would create a short circuit!**

Step 2

Attach the other end of the red lead to the motor contact with the red dot; attach the other end of the black lead to the other contact on the motor.

Fuel Cell Endurance Challenge

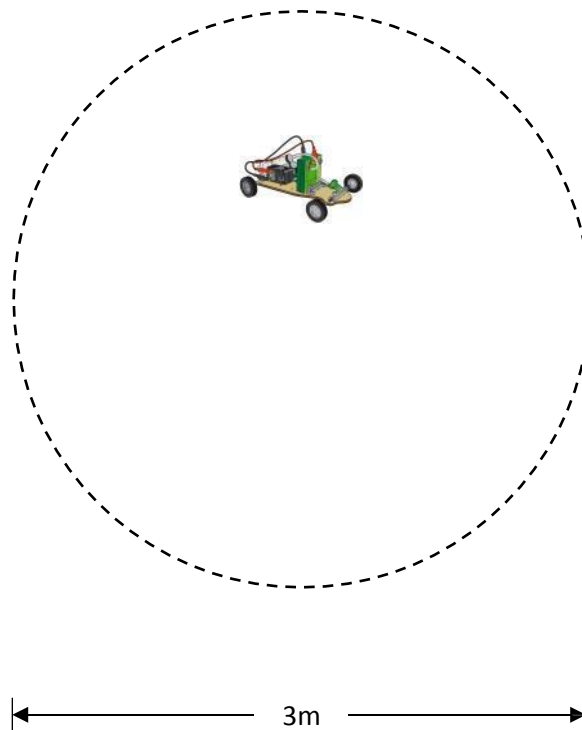
Objective: Student design teams will construct a Fuel Cell car that can travel in a circle for as long as possible.

- Track Specs: 3m-diameter circle
- Teams must release car in the circle
- Car must stay within the circle for the trial to be valid (if car leaves the circle, time stops at point of exit)
- Hydrogen must be stored using materials from the kit

Scoring:

- Design Teams get three trials
- Judge will determine score by recording the time for each trial on the scorecard.
- Final score is based on the sum of the three trials

Endurance Track



Fuel Cell Endurance with Weight Challenge

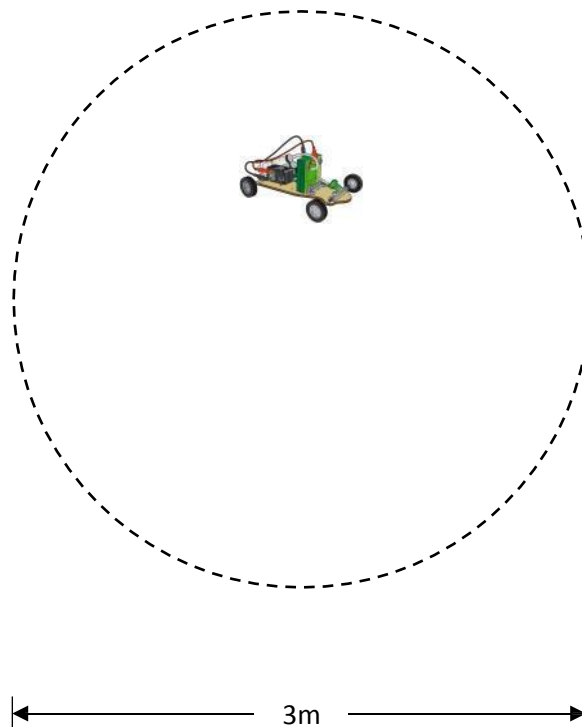
Objective: Student design teams will construct a Fuel Cell car that can travel in a circle for as long as possible carrying a 300-gram weight.

- Track Specs: 3m-diameter circle
- Teams must release car in the circle
- Car must stay within the circle for the trial to be valid (if car leaves the circle, time stops at point of exit)
- Hydrogen must be stored using materials from the kit
- Teams must use weights provided by judges at the track

Scoring:

- Design Teams get three trials
- Judge will determine score by recording the time for each trial on the scorecard.
- Final score is based on the sum of the three trials

Endurance Track



Fuel Cell Distance Challenge

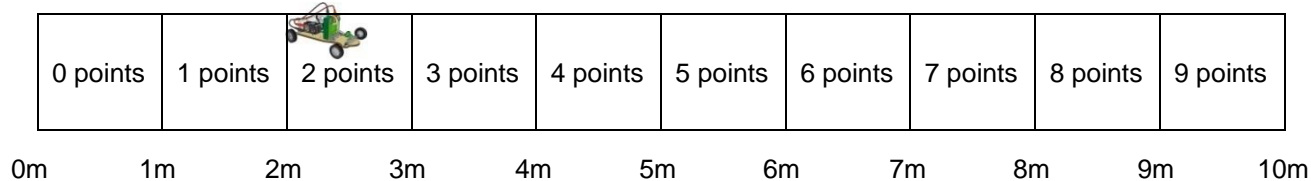
Objective: Student design teams will construct a Fuel Cell car that can travel as far as possible.

- The track specs are 10m long X 3m wide.
- Teams must release their Fuel Cell behind the 0m mark.
- The Fuel Cell must stay on the track for the trial to be valid (if Fuel Cell leaves the track, points are awarded at point of exit).

Scoring:

- Design teams get three trials.
- Final score is based on the sum of the three trials. The track judge will determine the point total for each trial.
- The point total is determined by adding the meters traveled plus the distance (in cm) traveled beyond the meter mark. Please see example below.
- Measurements are taken from the furthest point of travel of the wheels.

Distance Track



The Fuel Cell Car stopped beyond the 2m line (2 points awarded). The **front** wheel of the car is 57 cm from the 2m line. The point value for this trial is 2.57.

Fuel Cell Accuracy Challenge

Objective: Student design teams will construct a Fuel Cell car that can travel a specific distance.

- The track specs are 10m long X 3m wide.
- Teams must release their Fuel Cell behind the 0m mark.
- The Fuel Cell must stay on the track for the trial to be valid (if car leaves the track, points are awarded at point of exit).

Scoring: (Refer to Examples on Following Page)

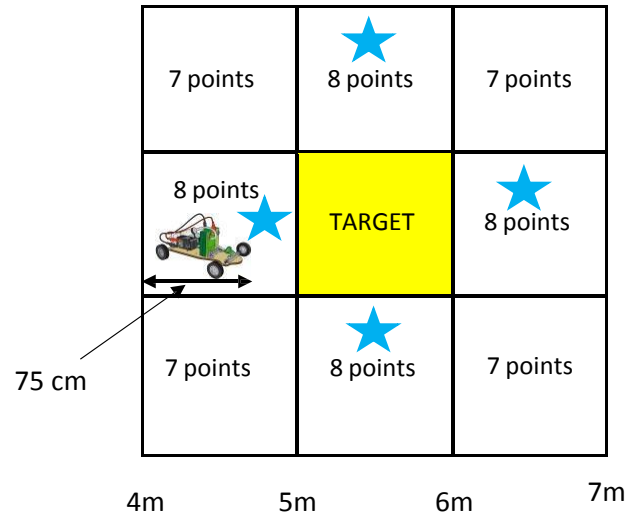
- Design teams get three trials.
- Final score is based on the sum of the three trials. The track judge will determine the point total for each trial.
- The point total is determined by two components:
 - The point value of the box where the car stops (50% or more of the car must be in the box to receive that box's point value)
 - The distance (in cm) from the corner or line furthest away from the center target to the wheel closest to the center target. Please see examples on the following page.
- If the car lands on the center target, the point value is determined by using the placement of the wheel that is closest to the center of the target.

Accuracy Track

	0 points	1 point	3 points	5 points	7 points	8 points	7 points	5 points	3 points	1 point	
Center Lane →	0 points	2 points	4 points	6 points	8 points	TARGET	8 points	6 points	4 points	2 points	← Outside Lanes
	0 points	1 point	3 points	5 points	7 points	8 points	7 points	5 points	3 points	1 point	
	0m	1m	2m	3m	4m	5m	6m	7m	8m	9m	10m

Scoring Example 1: Fuel Cell car stops to the front, back, left of Target (refer to starred boxes)

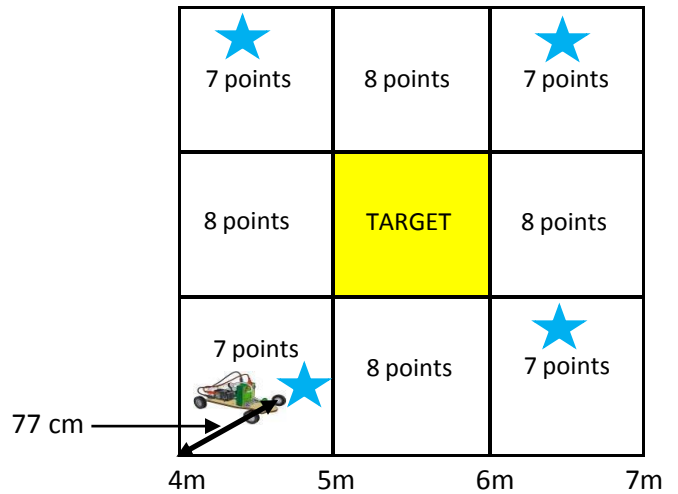
The front wheels of the car stopped 75 cm beyond the 4m line in the center lane, so the point value for this trial is 8.75.



Scoring Example 2: Fuel Cell car stops in a corner box (refer to starred boxes)

The wheel of the car closest to the target is 77 cm from the outside corner of the box, so the score for this trial is 7.77.

NOTE: No more than 7.99 points can be awarded for this box.



Scoring Example 3: Fuel Cell stops on the Target

The wheel of the car closest to the target is 9.6, so the score for this trial is 9.6.

Fuel Cell Speed Challenge

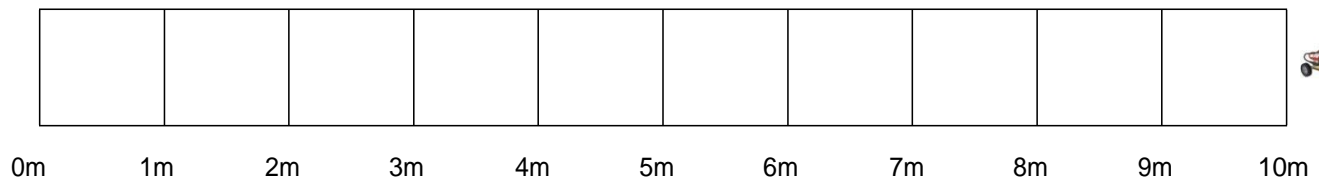
Objective: Student design teams will construct a Fuel Cell car that can travel 10m in the shortest time.

- Track Specs: 10m long X 1m wide
- Teams must release car behind the 0m mark
- Car must stay on the track for the trial to be valid, or exit the track past the 10m mark
- Hydrogen must be stored using materials from the kit
- Track judge will time each teams' trials using a stopwatch
 - Time starts when the car is released
 - Time stops when the car crosses the 10m line
 - If the car leaves the track before crossing the 10m line, no points will be awarded

Scoring:

- Design Teams get three trials
- Final score is based on the shortest elapsed time of the three trials

Speed Track



The Fuel Cell Car crossed the 10m line at 32.34 seconds. The point value for this trial is 32.34.

